

**Claims:**

1. A self-supporting reactive hot-melt adhesive element which comprises a reactive one-component hot-melt adhesive which is solid at room-temperature,  
5       said reactive one-component hot-melt adhesive comprising:
  - (i) at least one isocyanate which is solid or liquid at room-temperature; and
  - (ii) at least one isocyanate-reactive polymer and/or resin which is solid at room-temperature.
- 10       2. The reactive hot-melt adhesive element according to claim 1, characterized in that said isocyanate-reactive polymer and/or resin forms a solid matrix at room-temperature, especially wherein said isocyanate is embedded in said reactive polymer and/or resin matrix and/or wherein said isocyanate is  
15       homogeneously distributed over said reactive polymer and/or resin matrix.
- 20       3. The reactive hot-melt adhesive element according to claim 1, characterized in that said isocyanate is an aliphatic and/or aromatic di- and/or polyisocyanate, in particular with free terminal NCO-groups,  
25       especially wherein said isocyanate may be selected preferably from the group consisting of: diisocyanatodiphenylmethanes (MDIs), in particular 4,4'-diisocyanatodiphenylmethane and 2,4'-diisocyanatodiphenylmethane and mixtures of various diisocyanatodiphenylmethanes; 1,5-diisocyanatonaphthalene (NDI); diisocyanatotoluenes (TDIs), in particular 2,4-diisocyanatotoluene, as well as TDI-urethdiones, in particular dimeric 4-methyl-  
30       2,4-phenylene-diisocyanate (TDI-U), and TDI-carbamides; 1-isocyanato-3-isocyanatomethyl-3,5,5-trimethylcyclohexane (IPDI) and its isomers and derivatives, in particular di-, tri- and polymerisates, as well as IPDI-isocyanurate (IPDI-T); 3,3'-dimethylbiphenyl-4,4'-diisocyanate (TODI); 3,3'-diisocyanato-4,4'-dimethyl-N,N'-diphenylcarbamide (TDIH); as well as mixtures and prepolymers of the aforementioned compounds.

4. The reactive hot-melt adhesive element according to claim 1, characterized in that the content of free NCO-groups in said reactive hot-melt adhesive element is at least 0.5 %w/w, in particular at least 1 %w/w, preferably at least 1.5 %w/w, especially preferred at least 2 %w/w, relative to the reactive hot-melt adhesive element.  
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5. The reactive hot-melt adhesive element according to claim 1, characterized in that said isocyanate is a mixture of 4,4'-diisocyanatodiphenylmethane and 2,4'-diisocyanatodiphenylmethane, preferably with a content of 2,4'-diisocyanatodiphenylmethane exceeding 20 %w/w, in particular exceeding 30 %w/w, preferably exceeding 40 %w/w, especially preferred exceeding 50 %w/w, relative to the isocyanate mixture.  
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6. The reactive hot-melt adhesive element according to claim 1, characterized in that said isocyanate is a masked or blocked isocyanate, said masked or blocked isocyanate being able to split off the blocking or masking groups in particular during exposure to heat and/or moisture.  
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7. The reactive hot-melt adhesive element according to claim 1, characterized in that said isocyanate is an encapsulated or surface-deactivated isocyanate, said encapsulation or surface-deactivation being preferably broken up at temperatures exceeding room-temperature.  
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8. The reactive hot-melt adhesive element according to claim 1, characterized by an isocyanate content of 0.5 to 30 %w/w relative to the reactive hot-melt adhesive element.  
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9. The reactive hot-melt adhesive element according to claim 1, characterized in that said isocyanate-reactive polymer and/or resin comprises at least two isocyanate-reactive groups or isocyanate-reactive hydrogen atoms per molecule, in particular hydroxyl, amino, carboxyl and/or carbonamide groups.  
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10. The reactive hot-melt adhesive element according to claim 1, characterized in that said isocyanate-reactive polymer and/or resin has an average molecular weight exceeding 8,000 g/mol, in particular of 10,000 to 50,000 g/mol, preferably 10,000 to 30,000 g/mol, and/or that said isocyanate-  
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reactive polymer and/or resin is preferably selected from the group of isocyanate-reactive polymers and/or copolymers, especially isocyanate-reactive polyesters, polycaprolactone polyesters, polyethers, polyurethanes, polyamides, polytetrahydrofuranes, polyacrylates and polymethacrylates and their copolymers and mixtures.

11. The reactive hot-melt adhesive element according to claim 1, characterized in that said isocyanate-reactive polymer and/or resin and said isocyanate are homogeneously distributed in each other.

12. The reactive hot-melt adhesive element according to claim 1, characterized by a content of said isocyanate-reactive polymer and/or resin of from 20 to 90 %w/w relative to the reactive hot-melt adhesive element.

13. The reactive hot-melt adhesive element according to claim 1, characterized in that it also contains at least one catalyst, preferably in amounts of from 0.01 to 5 %w/w relative to the reactive hot-melt adhesive element, said catalyst preferably being homogeneously distributed over said isocyanate-reactive polymer and/or resin matrix and embedded herein, especially wherein said catalyst may be a catalyst common or known from polyurethane chemistry, in particular selected from the group consisting of organic tin compounds such as dibutyl tin dilaurate (DBTL) or alkylmercaptide compounds of dibutyl tin; organic iron, lead, cobalt, bismuth, antimony and zinc compounds and mixtures of these compounds; and catalysts based on amines such as tertiary amines, 1,4-diazabicyclo-[2,2,2]-octane and dimorpholinodiethyl ether; as well as mixtures of these compounds.

14. The reactive hot-melt adhesive element according to claim 1, characterized in that it also comprises at least one non-isocyanate-reactive polymer, wax and/or resin, which is preferably homogeneously distributed over said isocyanate-reactive polymer and/or resin matrix, preferably in amounts of from 0 to 60 %w/w relative to the reactive hot-melt adhesive element, especially wherein said non-isocyanate-reactive polymer, wax and/or resin may be preferably selected from the group consisting of:

- (i) aliphatic, cyclic or cycloaliphatic hydrocarbon resins, terpene phenol resins, cumarone indene resins,  $\alpha$ -methylstyrene resins, polymerized liquid resin esters or ketaldehyde resins, in particular resins with low acid values preferably of less than 1 mg KOH/g;
  - 5 (ii) ethylene/vinyl acetate polymers or copolymers, in particular those with vinyl acetate contents of between 12 and 40 %w/w, in particular 18 to 28 %w/w, and/or with melt indices (MFIs, DIN 53735) of 8 to 800, in particular 150 to 500;
  - 10 (iii) polyolefins, in particular with average molecular weights of 5,000 to 25,000 g/mol, preferably 10,000 to 20,000 g/mol, and/or with ring and ball softening ranges of between 80 and 170 °C, preferably between 80 and 130 °C;
  - (iv) (meth)acrylates such as styrene(meth)acrylates; and
  - 15 (v) polyolefin waxes, in particular polyethylene and polypropylene waxes, and modified waxes on this basis;
- as well as mixtures of these compounds.
15. The reactive hot-melt adhesive element according to claim 14, characterized in that said non-isocyanate-reactive polymers, waxes and/or resins combine  
20 with said isocyanate-reactive polymers and/or resins to form a matrix into which said isocyanates and optionally said other constituents of the reactive hot-melt adhesive element are incorporated, preferably in homogeneous distribution.
- 25 16. The reactive hot-melt adhesive element according to claim 1, characterized in that it also comprises at least one isocyanate-reactive mono-functional additive, preferably in amounts of from 0 to 20 %w/w relative to the reactive hot-melt adhesive element, said mono-functional additive being preferably selected from the group consisting of mono-functional amines, alcohols,  
30 mercaptans and other mono-functional additives which comprise an isocyanate-reactive functional group.

17. The reactive hot-melt adhesive element according to claim 1, characterized in that the individual constituents or contents are embedded and homogeneously distributed in each other.
- 5 18. The reactive hot-melt adhesive element according to claim 1, characterized in that it is non-sticky or non-adhesive at room-temperature and becomes sticky or adhesive at temperatures above room-temperature, in particular at temperatures of from 60 °C to 160 °C, and begins to cross-link after briefly warmed above room-temperature, in particular to temperatures of from  
10 60 °C to 160 °C, wherein the duration of cross-linking is less than 10 minutes, in particular less than 5 minutes, at temperatures ranging from 100 °C to 160 °C, in particular in the case of solid isocyanates.
- 15 19. The reactive hot-melt adhesive element according to claim 18, characterized in that, when the cross-linking process has been initiated via heating to temperatures above room-temperature, in particular 100 °C to 160 °C, followed by immediate cooling to room-temperature, the duration of cross-linking generally lasts for about 5 to 8 days at room-temperature, in particular in the case of solid isocyanates.
- 20 20. The reactive hot-melt adhesive element according to claim 1, characterized in that it cross-links during exposure to heat and/or moisture.
- 25 21. The reactive hot-melt adhesive element according to claim 1, characterized in that it has a layer thickness of 10 µm to 1,000 µm, in particular 50 µm to 500 µm, preferably 100 µm to 300 µm.
- 30 22. The reactive hot-melt adhesive element according to claim 1, characterized in that it has the form of a foil, film, strip or reactive adhesive tape, which may optionally be wound into a roll and/or stored in a cassette.

23. The reactive hot-melt adhesive element according to claim 1, characterized in that it contains the following constituents or contents:

- said isocyanates in a quantity of from 0.5 to 30 %w/w;
- said isocyanate-reactive polymers and/or resins in a quantity of from 20 to 90 %w/w;
- said isocyanate-reactive, mono-functional additives in a quantity of from 0 to 20 %w/w;
- said non-isocyanate-reactive polymers, waxes and/or resins in a quantity of from 0 to 60 %w/w;
- optionally, said catalysts in a quantity of up to 5 %w/w, in particular in amounts of from 0.01 to 5 %w/w;
- optionally, said additives for improving heat conductivity and/or sensitivity to radiation induction in a quantity of up to 25 %w/w, in particular in amounts of from 1 to 25 %w/w, preferably 5 to 20 %w/w;

all amounts being based on the reactive hot-melt adhesive element.

24. A self-supporting reactive hot-melt adhesive element, especially in the form of a foil, film, strip or reactive adhesive tape, which comprises a reactive one-component hot-melt adhesive which is solid at room-temperature,

said reactive one-component hot-melt adhesive comprising:

- (i) about 0.5 to about 30 %w/w, based on said reactive hot-melt adhesive element, of at least one aliphatic or aromatic di- or polyisocyanate which is solid or liquid at room-temperature; and
- (ii) about 20 to about 90 %w/w, based on said reactive hot-melt adhesive element, of at least one isocyanate-reactive polymer and/or resin which is solid at room-temperature and has an average molecular of at least 8,000 g/mol, said isocyanate-reactive polymer and/or resin comprising at least two isocyanate-reactive groups or functions per molecule;

wherein said isocyanate-reactive polymer and/or resin forms a solid matrix at room-temperature, into which said di- or polyisocyanate is embedded in homogeneous distribution, and wherein the content of free NCO-groups in the reactive hot-melt adhesive element is at least about 0.5 %w/w, relative to the reactive hot-melt adhesive element.

25. A self-supporting reactive hot-melt adhesive element, especially in the form of a foil, film, strip or reactive adhesive tape, which comprises a reactive one-component hot-melt adhesive which is solid at room-temperature,

said reactive one-component hot-melt adhesive comprising:

5 (i) about 0.5 to about 30 %w/w, based on said reactive hot-melt adhesive element, of a mixture of at least two aliphatic and/or aromatic di- and/or polyisocyanates which are solid or liquid at room-temperature, wherein at least one of said di- and/or polyisocyanates is an unsymmetrically substituted di- and/or polyisocyanate comprising isocyanate functions of  
10 different reactivity; and

(ii) about 20 to about 90 %w/w, based on said reactive hot-melt adhesive element, of at least one isocyanate-reactive polymer and/or resin which is solid at room-temperature and has an average molecular of at least 8,000 g/mol, said isocyanate-reactive polymer and/or resin comprising at  
15 least two isocyanate-reactive groups or functions per molecule;

wherein said isocyanate-reactive polymer and/or resin forms a solid matrix at room-temperature, into which said isocyanate mixture is embedded in homogeneous distribution, and wherein the content of free NCO-groups in the reactive hot-melt adhesive element is at least about 0.5 %w/w, relative to  
20 the reactive hot-melt adhesive element.

26. A self-supporting reactive hot-melt adhesive element, especially in the form of a foil, film, strip or reactive adhesive tape, which comprises a reactive one-component hot-melt adhesive which is solid at room-temperature,

25 said reactive one-component hot-melt adhesive comprising:

(i) about 0.5 to about 30 %w/w, based on said reactive hot-melt adhesive element, of a mixture of 4,4'-diisocyanatodiphenylmethane and 2,4'-diisocyanatodiphenylmethane, preferably with a content of 2,4'-diisocyanatodiphenylmethane exceeding 20 %w/w relative to said  
30 mixture; and

(ii) about 20 to about 90 %w/w, based on said reactive hot-melt adhesive element, of at least one isocyanate-reactive polymer and/or resin which is solid at room-temperature and has an average molecular of at least

8,000 g/mol, said isocyanate-reactive polymer and/or resin comprising at least two isocyanate-reactive groups or functions per molecule;

wherein said isocyanate-reactive polymer and/or resin forms a solid matrix at room-temperature, into which said isocyanate mixture is embedded in homogeneous distribution, and wherein the content of free NCO-groups in the reactive hot-melt adhesive element is at least about 0.5 %w/w, relative to the reactive hot-melt adhesive element.

27. A self-supporting reactive hot-melt adhesive element, especially in the form of a foil, film, strip or reactive adhesive tape and having a layer thickness in the range of from about 10  $\mu\text{m}$  to about 1,000  $\mu\text{m}$ , said self-supporting reactive hot-melt adhesive element comprising a reactive one-component hot-melt adhesive which is solid at room-temperature and comprises:

- about 0.5 to about 30 %w/w of at least one isocyanate which is solid or liquid at room-temperature;
- about 20 to about 90 %w/w of at least one isocyanate-reactive polymer and/or resin which is solid at room-temperature;
- optionally, up to about 20 %w/w of at least one mono-functional additive;
- optionally, up to about 60 %w/w of at least one non-isocyanate-reactive polymer, wax and/or resin;
- optionally, up to about 5 %w/w of at least one catalyst;
- optionally, up to about 25 %w/w of at least one additive for improving heat conductivity and/or sensitivity to radiation induction;

all amounts being based on said reactive hot-melt adhesive element,

wherein said isocyanate-reactive polymer and/or resin forms a solid matrix at room-temperature, into which said isocyanate is embedded in homogeneous distribution and wherein the content of free NCO-groups in the reactive hot-melt adhesive element is at least about 0.5 %w/w, in particular at least about 1 %w/w, preferably at least about 1.5 %w/w, especially preferred at least about 2 %w/w, relative to the reactive hot-melt adhesive element.



28. A process for manufacturing the reactive hot-melt adhesive element according to claims 1 to 27, said process comprising the following steps:

- 5       – Mixing the individual constituents or contents, as defined in claims 1 to 27, in particular while mildly heating, but without a reaction between the individual constituents or contents taking place in the case of solid isocyanates;
- if necessary, letting the resulting mixture or mass cool and/or harden;
- processing the homogeneous mixture or mass fabricated in this way to a film, if necessary while mildly heating to above room-temperature, but  
10       without a reaction between the individual constituents or contents taking place;
- if necessary, letting the films obtained in this way cool to room-temperature; and
- 15       – if necessary, further processing, in particular dimensioning (such as into foils, smaller pieces etc.) and/or winding into rolls.

29. An adhesive bonding process for the permanent bonding of substrates to be joined, said process using the reactive hot-melt adhesive element according to claims 1 to 27 and said process comprising the following steps:

- 20       a) Providing a first and second substrate to be bonded and the reactive hot-melt adhesive element according to claims 1 to 27;
- b) applying the reactive hot-melt adhesive element according to claims 1 to 27 to the first of said two substrates, in particular during exposure to heat and/or pressure, if necessary while melting the reactive constituents and  
25       thereby initiating the cross-linking process;
- c) joining said first and second substrate while applying said second substrate part on the side of said first substrate provided with the reactive hot-melt adhesive element, preferably under pressure;
- d) pressing together said two substrates, if necessary while initiating the cross-linking process, in particular during exposure to heat and/or  
30       moisture; and finally
- e) hardening or curing, if necessary during exposure to pressure and/or heat and/or moisture.

30. An adhesive bonding process for the permanent bonding of substrates to be joined, said process using the reactive hot-melt adhesive element according to claims 1 to 27 and said process comprising the following steps:

- 5 a) Providing a first and second substrate to be bonded and the reactive hot-melt adhesive element according to claims 1 to 27;
- b) joining said first and second substrate, with said reactive hot-melt adhesive element being positioned between said two substrates;
- 10 c) pressing together said two substrates joined together in step b), in particular during exposure to heat and/or moisture, preferably while melting the reactive constituents and thereby initiating the cross-linking process; and finally
- d) hardening or curing, if necessary during exposure to pressure and/or heat and/or moisture.